21609.7-EL-H

SOLID-STATE TRAVELLING WAVE AMPLIFIERS BASED ON MULTI-STREAM INSTABILITY

FINAL REPORT

BY

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NOVEMBER 27, 1987

TO

CONTRACT NUMBER: DAAG29-84-G-0058

DEPARTMENT OF ELECTRICAL ENGINEERING
HOWARD UNIVERSITY

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REPORT DOCUMENTATION PAGE

AD-A189 566

1a.	1b. RESTRICTIVE MARKINGS
2a.	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S) ARO 21609.7-EL-H
6a. NAME OF PERFORMING ORGANIZATION Department of Electrical Engrg / Howard University 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION U. S. Army Research Office
6c. ADDRESS (City, State, and ZIP Code) Washington, D.C. 20059	7b. ADDRESS (City, State, and ZIP Code) P. O. Box 12211 Research Triangle Park, NC 27709-2211
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U. S. Army Research Office 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DAAG29-84-G-0058
8c. ADDRESS (City, State, and ZIP Code) P. O. Box 12211 Research Triangle Park, NC 27709-2211	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification) (Unclassified)
Solid-State Travelling-wave Amplifiers Based on Multistream Instability

12. PERSONAL AUTHOR(S) Yen-Chu Wang

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 9/1/84 TO 8/31/87	1987/11-25	6

16. SUPPLEMENTARY NOTATION
The view, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A method for the amplification of microwaves, based on the space-charge interaction of electron streaming sheets with different velocities in a semiconductor is obtained. A maximum of 18 dB gain in the 3-90 GHz band is predicted. Comparisons of MESFET, bipolar transistor, and state induction transistor Class C amplifiers show that silicon bipolar type is preferred. A completely new approach to the phenomenological quantal dissipation problem has been formulated and solved by Dirac's constrained dynamics. Boson operator, generalized to dissipative oscillator is also obtained.

DTIC ELECTE FEB 0 2 1988 S D

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code) / 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

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STATEMENT OF THE PROBLEM STUDIES

A method for the amplification of microwaves, based on the space-charge interaction of electron streaming sheets with different velocities in a semiconductor, is obtained. A theory of an n^+ - n - n^+ GaAs diode is formulated. We consider electron-charged sheets, each of which has a different average velocity due to the doping concentration gradient along the thickness direction. A dispersion relation is obtained for space-charge waves in the semiconductor, and a numerical analysis is used to claculate the propagation constant.

Comparisons of MESFET, bipolar transistor and static induction transistor class C amplifiers have been presented. Simplified modelliing of the I-V charcteristics and input circuits is employed.

In view of the importance of damped harmonic oscillators as a model in ultrasmall solid state devices, Boson operators for generalized quantal harmonic oscillators with time-dependent mass, frequency, damping and driving forces have been presented. A constrained dynamical formulation of the dampled harmonic oscillator system has been obtained. Then generalized classical Hamiltonian based on the Dirac theory and its quantal counterpart are given.

Underline of the Most Important Results

1. In a solid-state travelling-wave amplkifier a maximum of 18dB gain in the 3-90 GHz band can be achieved.

2. The silicon bipolar transistor leads among the three divices (bipolar, MESFET and static indiction transistor) in output power, gain and efficiency. The InP MESFET followed by the GaAs can give power comparable to thie bipolar type with slightly lower gain and efficiency. The static induction transistor has higher power potential but its gain and efficiency are both moderate.

3. A completely new approach to the phenomenological quantal dissipation problem has been formulated and solved based on Dirac's constrained dynamics.

List of All Publications Published

1. Y. Wang, "Constrained Dynamics of Dampled Harmonic Oscillaotor, J. Phys. A: Math. Gen. 20 (1987) 4745-4755.

2. Y. Wang, "Boson Operators for Generalized Harmonic Oscillators", J. Phys. JA: Math Gen 20 (1987) 4739-4744.

3. Y. Wang and H. Jahandoost, "Solid-State Travelling Wave Amplifiers based on Multi-Stream Instability", Int. J. Electronics, 1985, 58, 4, 571-585.

4. Y. Wang, (Invited paper), Comparison of MESFET, Bipolar Transistor and Induction Transistor Class C Amplifiers", Int. J. Electronics, 1985, 59, 1, 1-17.

5. Y. Wang, "Fundamental Performance Limitations for Transit-Tme Devices", Int. J. Electronics, 1985, 58, 6, 1037-1040.

6. Y. Wang, "Singular Perturbation Applied to the Relaxation Oscillations of the Van der Pol Oscillator", Int. J. Electronics, 1987, 62, 3.

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Mr. Habte Mered (Master of Engineering in E.E. December 1987).

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1. Y. Wang, "Applications of Lagrange Expansion to the Problem of Shielded Surface Waves", IEEE Trans. on Microwave Theory & Techniques, April, 1969.

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19. Y. Wang, "Constrained Dynamics of Damped Harmonic Oscillator", J. Phys. A: Math. Gen., 4745-4755, 1987.

20. Y. Wang, "Singular Perturbation Applied to the Relaxation Oscillations of the Van der Pol Oscillator", Int. J. Electronics, 1987, vol. 63, No. 4, 489-498.